# 2007 IEPR
# Scenario Analyses Project
# Aging Power Plant Retirement Study

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# Aging Power Plant Study

- As noted by Staff, the Study:
  - Was undertaken to develop an understanding of the implications of current retirement policy on both resource requirements and impacts on the transmission grid
  - Was limited to the SCE transarea
  - Identified replacement capacity requirements for each of the key scenario strategies
  - Examined the impacts of all retirements in 2012 and a phased retirement program
  - Attempted to reflect local capacity requirements in identifying replacement capacity

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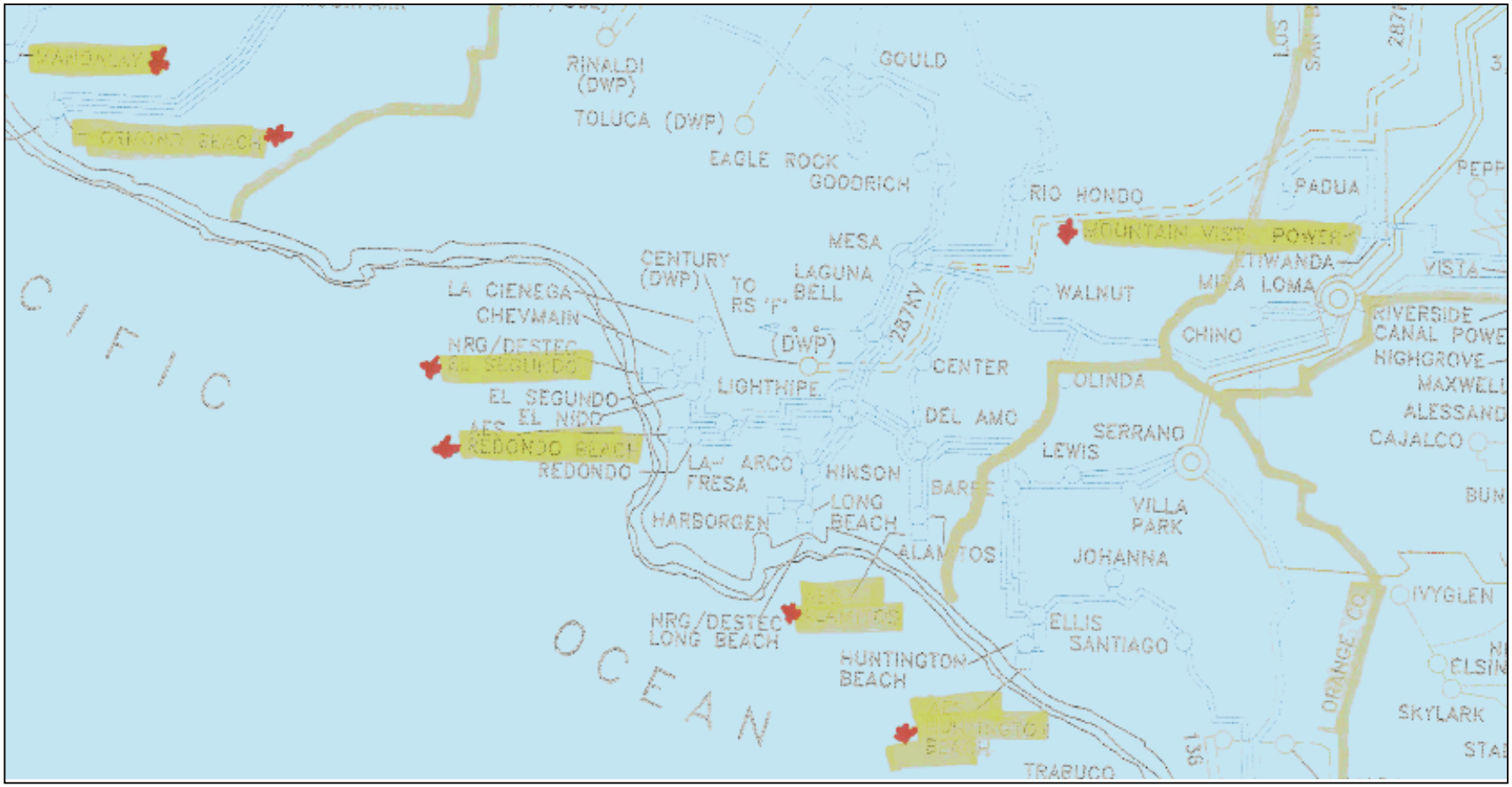
# Aging Power Plant Study

- As noted by Staff, the findings of the Study were as follows:
  - Amounts and location of replacement capacity have to be assessed along with transmission impacts
  - Capacity additions will be at least partially different in conjunction with resource mix build out
  - Retirement of large blocks of generation by 2012 creates timing issues with the build out timeline for energy efficiency and renewables
  - Local capacity requirements adopted by the CPUC and CAISO constrain choices

# Locations of Aging Power Plants in SCE Area

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# Major Areas of Discussion

- Development of the initial powerflow base cases and the process used in and results of initial studies
- Development of updated base cases reflecting new line rating information and additional thematic scenarios and the results of studies on updated cases
- Development of phased retirement base cases and the results of studies on these cases
- Preliminary assessment of ability to meet Local Capacity Requirement (LCR)
- Coordination with other parties
- Study conclusions

# Development of Initial 2012 Base Case

- This base case was prepared to assess the impact of potential retirements in 2012 and was developed from the WECC 2016 summer peak base case by modifying it to:
  - Reflect 1-in-10 year loads in California for 2012 based on information in the Energy Commission's June 2006 load forecast.
  - Allocate the resultant SCE transarea load among the various load busses using information from SCE's most recent 10-year transmission plan
  - Model new renewable resources (wind and biomass) based on levels in thematic scenario Case 1B

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# Development of 2012 Base Case

- Other modifications to the 2012 base case included:
  - Adding the following planned transmission projects:
    - The Tehachapi Renewable Transmission Project
    - The Harquahala-Devers 500-kV line
    - The Devers-Valley #2 500-kV line
    - The 500-kV Sunrise Project between the Imperial Valley and the San Diego area
  - Adding new thermal generation (peakers in the Long Beach and Devers areas and combined cycle capacity in the Blythe area) for which SCE had announced purchase power agreements

# Development of 2012 Base Case

- In addition, the 2012 base case was modified to include:
  - Other potential new thermal generation, as required to meet load, based on information in the California ISO's generation interconnection queue of January 26, 2007 and the most recent version of SCE's WDAT generation interconnection queue

# Development of 2012 Base Case

- The 2012 base case modeled 4,870 MW of Aged Power Plants in the LA Basin, as follows:
  - Alamitos – Six units with a combined capacity of 1,930 MW
  - Huntington Beach – Two units with a combined capacity of 400 MW
  - Redondo Beach – Four units with a combined capacity of 1,240 MW
  - El Segundo – Two units with a combined capacity of 660 MW
  - Etiwanda – Two units with a combined capacity of 640 MW

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# Development of 2012 Base Case

- This 2012 base case also modeled 1,800 MW of Aged Power Plants in Ventura County, as follows:
  - Ormond Beach – Two units with a combined capacity of 1,400 MW
  - Mandalay -Two units with a combined capacity of 400 MW

# Development of Initial Base Cases for 2016 and 2020

- Developed from the 2012 case to assess the impacts of load growth on the findings of the 2012 studies
- These cases also:
  - Reflected 1-in-10 year loads in California based on information in the Energy Commission's June 2006 load forecast
  - Modeled new renewable resources (wind and biomass) based on levels in thematic scenario Case 1B

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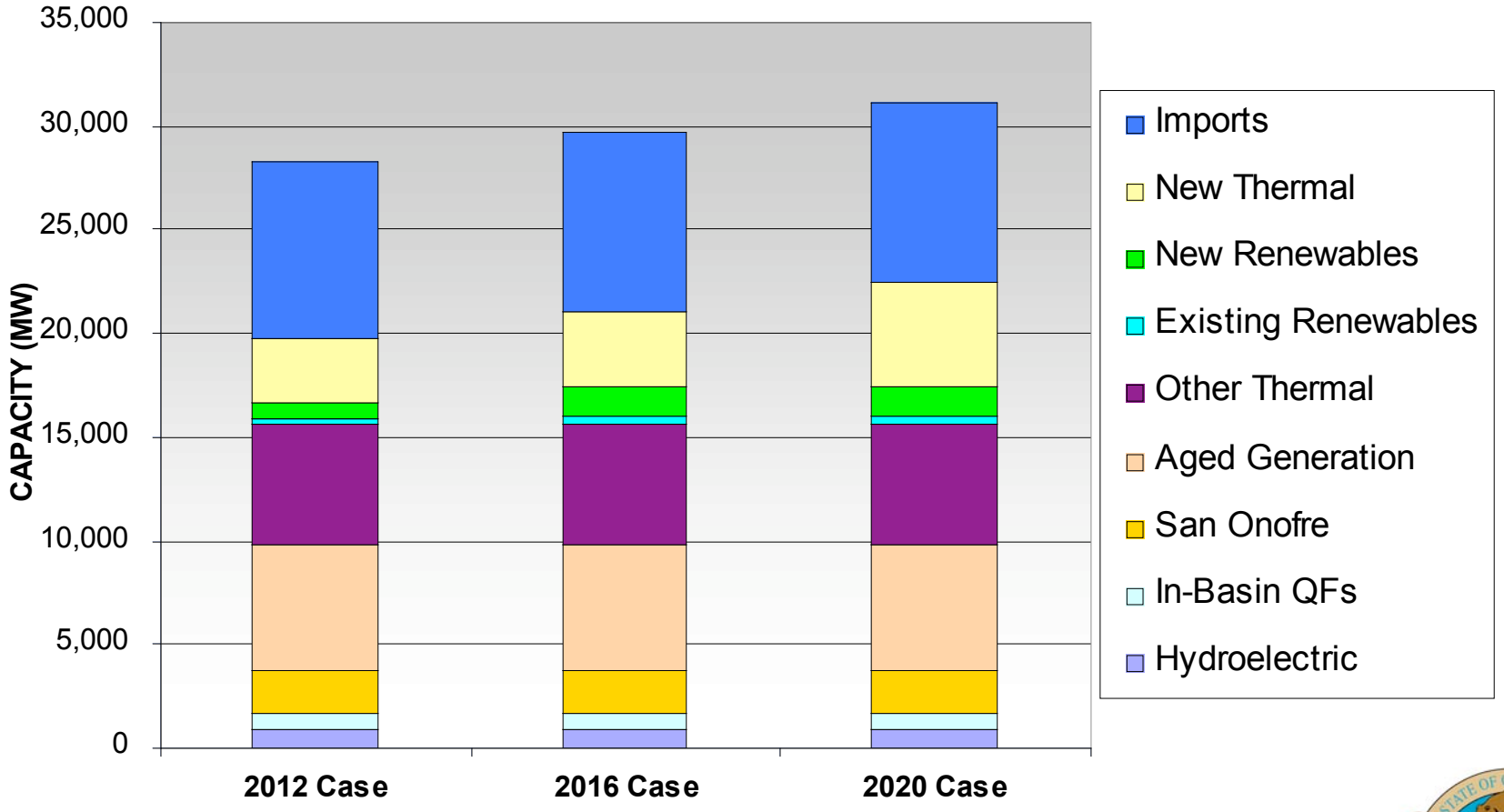
# Development of Base Cases for 2016 and 2020

- In addition, these base cases modeled:
  - The proposed 500-kV Green Path Project between the Imperial Valley and the system of the Los Angeles Department of Water and Power
  - Other potential new thermal generation, as required to meet load, based on information in the California ISO's generation interconnection queue of January 26, 2007 and the most recent version of SCE's WDAT generation interconnection queue

# Resource Stacks for Initial Base Cases

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# Approach Used in Initial Studies

- Perform powerflow studies to:
  - Identify the amounts of Aged Plant generation that could be retired in 2012 without causing adverse impacts on the transmission system
  - Assess the impacts of load growth on the above findings using the 2016 and 2020 cases
- Studies assessed impacts for:
  - Category A (N-0), Category B (L-1), and Category C (L-2) conditions on all 230-kV and 500-KV lines in the SCE area without any generator outages and with one San Onofre unit out of service
  - Overlapping outages of most of the 500-kV lines in the SCE area and for 40 of the most critical 230-kV lines in the SCE area

# Approach Used in Initial Studies

- Identify potential methods of mitigating impacts noted in the above powerflow studies
- Assess system impacts if all of the Aged Plant generation was retired in 2012

# Results of Initial Studies – 2012 Case

- Studies found that 2,340 MW of LA Basin generation could be retired if:
  - Portions of the Chino-Mira Loma #1 line were reconductored and the wave traps on the line were removed or upgraded
  - The wave traps on the Redondo Beach-La Fresa 230-kV lines were removed (as proposed in SCE's 10-year plan)
  - The Barre-Ellis (approximately 13 miles in length) was reconductored
  - The required replacement capacity was developed in the eastern portion of the SCE system. Approximately 3,540 MW of capacity would be required to replace the retired plants, accommodate increased losses, and provide back-up in the event of a SONGS outage

# Results of Initial Studies – 2012 Case

- Studies also found that 1,800 MW of Ventura County generation could be retired if:
  - The Antelope-Pardee 230-kV line (planned as part of the Tehachapi Project) was in service
  - The limiting elements on the Pardee-Moorpark #2 and #3 lines were upgraded
  - The required replacement capacity (approximately 1,840 MW) was developed in the appropriate portions of the SCE system

# Results of Initial Studies – 2012 Case

- The retired capacity consisted of:
  - In the LA Basin:
    - 980 MW (Units 1 through 4) at Alamitos
    - 400 MW (Units 1 and 2) at Huntington Beach
    - 340 MW (Units 5 and 6) at Redondo Beach
    - 620 MW (Units 3 and 4) at Etiwanda
  - In Ventura County:
    - 1,400 MW (Units 1 and 2) at Ormond Beach
    - 400 MW (Units 1 and 2) at Mandalay
- Assumed replacement capacity included:
  - 4,140 MW of thermal generation within the main SCE grid
  - 1,140 MW of thermal generation at Mohave/El Dorado
  - 100 MW of imports from Arizona

# Overloaded Lines in 2012 Initial Studies


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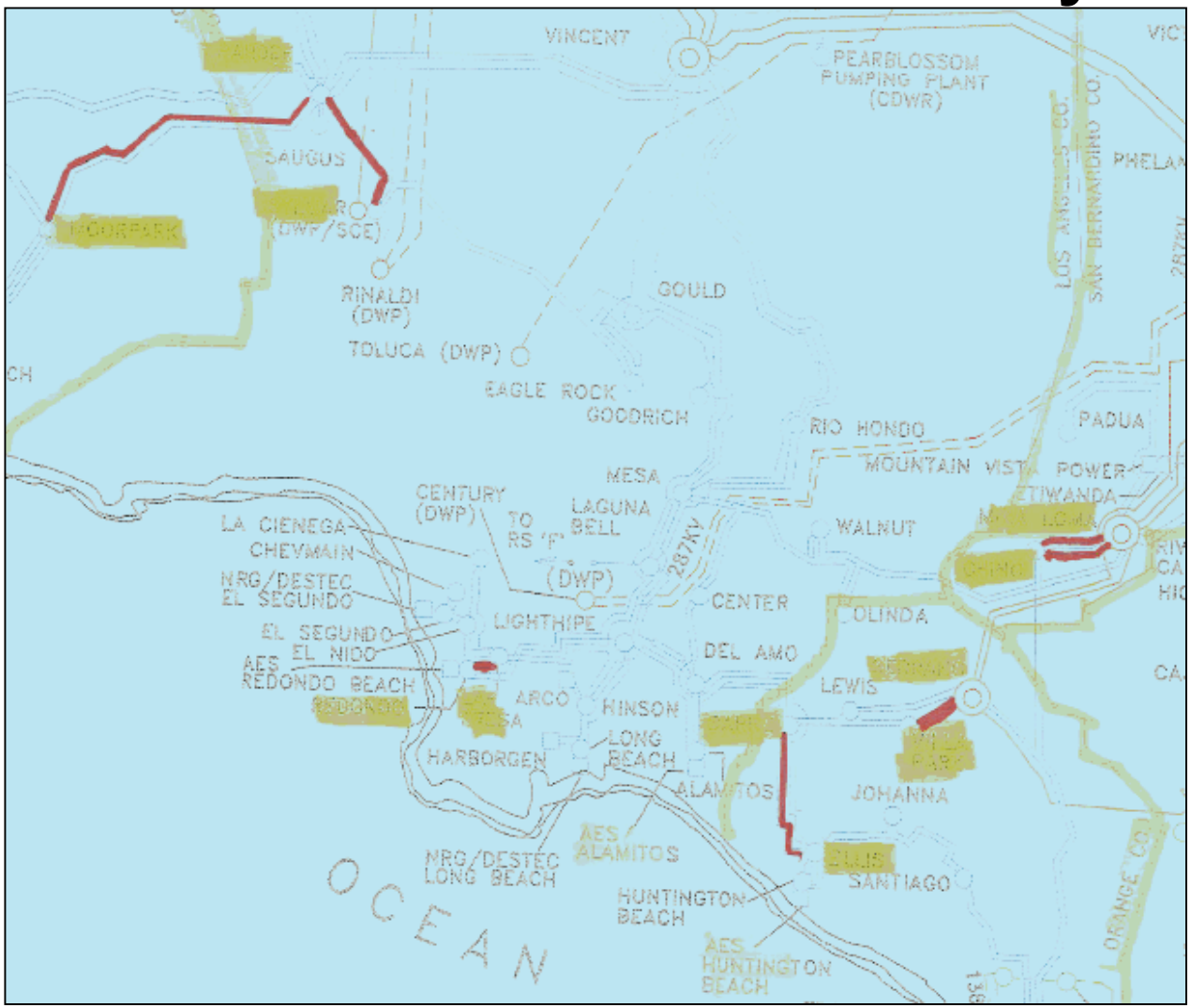
# Results of Initial Studies – 2016 Case

- Studies on this case indicated that load growth in the SCE area would result in additional overloads if 4,140 MW of Aged Plants were retired. Mitigation would require:
  - Reconductoring the balance of the Chino-Mira Loma #1 230-kV line (7 miles) and the Chino-Mira Loma #3 230-kV line (8 miles)
  - The development of a method to mitigate a small overload (2%) on the Serrano-Villa Park #1 and #2 230-kV lines
- The studies also indicated that overloads on the Pisgah-Lugo 230-kV lines (resulting from new renewable resources in the Pisgah area) could occur

# Results of Initial Studies – 2020 Case

- Studies on this case indicated that, with 4,140 MW of retirements, load growth in the SCE area would result in additional overloads. Mitigation would require:
  - That the Antelope-Pardee line begin operation at its design voltage of 500-kV
  - That the Vincent-Santa Clara 230-kV line is looped into Pardee and the resultant Vincent-Pardee line begin operation at its design voltage of 500-kV
  - Reconductoring of the Serrano-Villa Park #1 and #2 230-kV lines (each 3 miles in length)
  - Upgrading the series capacitors in the El Dorado-Lugo 500-kV line

# Initial Studies - Overloaded Lines by 2020

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# Results of Studies – 2012 Case With All Aged Plants Retired

- Studies on the 2012 base case with all 6,650 MW of Aged Plants retired indicated that significant impacts would occur
- Mitigation of these impacts would require that:
  - Five additional 230-kV lines in the LA Basin (with a total length of 30 miles) would have to be reconductored
  - The limiting elements on three other 230-kV lines would have to be upgraded
  - Approximately 500 MVAR of reactive support would have to be installed in the SCE area

# Results of Studies – 2012 Case With All Aged Plants Retired

- In addition to requirement for transmission system upgrades, these studies indicated that approximately 8,000 MW of new capacity would be required in the eastern portion of the SCE system to replace the retired plants, accommodate increased losses, and provide back-up in the event of a SONGS outage
- Because of the costs and lead time required to plan, permit, and develop both the required replacement capacity and transmission upgrades, retirement of all of the Aged Plant generation in the SCE area by 2012 would be very problematical

# Overloaded Lines - All Retirements in 2012

# Development of Updated Base Cases

- After the initial studies discussed above were completed, NCI and the Energy Commission staff learned that SCE had modified the ratings for most of its 230-kV lines
- In addition, the Energy Commission staff had, as part of the Scenarios Project, postulated scenarios with higher levels of energy efficiency and renewable resources than had been assumed in the initial studies
- As a result of the above, updated base cases for 2012, 2016, and 2020 were developed

# Thematic Scenarios Reflected in Updated Base Cases

| Resource Type | Case 1B Compliance With Current Requirements | | | Case 3A High Efficiency in California | | | Case 4A High Renewables in California | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2016 | 2020 | 2012 | 2016 | 2020 | 2012 | 2016 | 2020 |
| Biomass | 50 | 50 | 50 | 50 | 50 | 50 | 26 | 131 | 235 |
| Wind | 265 | 614 | 668 | 265 | 613 | 668 | 207 | 883 | 1,516 |
| Solar (CSP) | 305 | 718 | 718 | 305 | 718 | 718 | 131 | 654 | 1,175 |
| Geothermal | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 147 | 264 |
| Total | 620 | 1,382 | 1,436 | 620 | 1,381 | 1,436 | 393 | 1,815 | 3,190 |
| Energy Efficiency | 874 | 1,637 | 2,269 | 1,145 | 2,292 | 3,427 | 874 | 1,637 | 2,269 |
| Solar (PV) | 63 | 139 | 150 | 63 | 139 | 150 | 303 | 789 | 854 |
| Total | 937 | 1,776 | 2,419 | 1,208 | 2,431 | 3,577 | 1,177 | 2,426 | 3,123 |

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# Modeling of Scenario Resources

## (Dependable Capacity, MW)

| | Case 1B | | | Case 3A | | | Case 4A | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2016 | 2020 | 2012 | 2016 | 2020 | 2012 | 2016 | 2020 |
| **Energy Efficiency** | 874 | 1,637 | 2,269 | 1,145 | 2,292 | 3,427 | 874 | 1,637 | 2,269 |
| **Solar PV** | 64 | 139 | 150 | 63 | 139 | 150 | 303 | 789 | 854 |
| **Biomass** | 50 | 50 | 50 | 50 | 50 | 50 | 26 | 131 | 235 |
| **Geothermal** | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 147 | 264 |
| **Solar (CSP)** | | | | | | | | | |
| Pisgah Area | 305 | 479 | 479 | 305 | 479 | 479 | 131 | 305 | 539 |
| Kramer Area | 0 | 91 | 91 | 0 | 91 | 91 | 0 | 131 | 244 |
| Mohave Area | 0 | 148 | 148 | 0 | 148 | 148 | 0 | 218 | 392 |
| Total | 305 | 718 | 718 | 305 | 718 | 718 | 131 | 654 | 1,175 |
| **Wind** | | | | | | | | | |
| Devers Area | 31 | 86 | 92 | 29 | 86 | 94 | 29 | 86 | 94 |
| Tehachapi Area | 236 | 527 | 574 | 236 | 527 | 574 | 178 | 527 | 1,021 |
| Pisgah Area | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 123 | 149 |
| Eldorado Area | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 104 | 209 |
| Victor Area | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 43 |
| Total | 267 | 613 | 666 | 265 | 613 | 668 | 207 | 883 | 1,516 |

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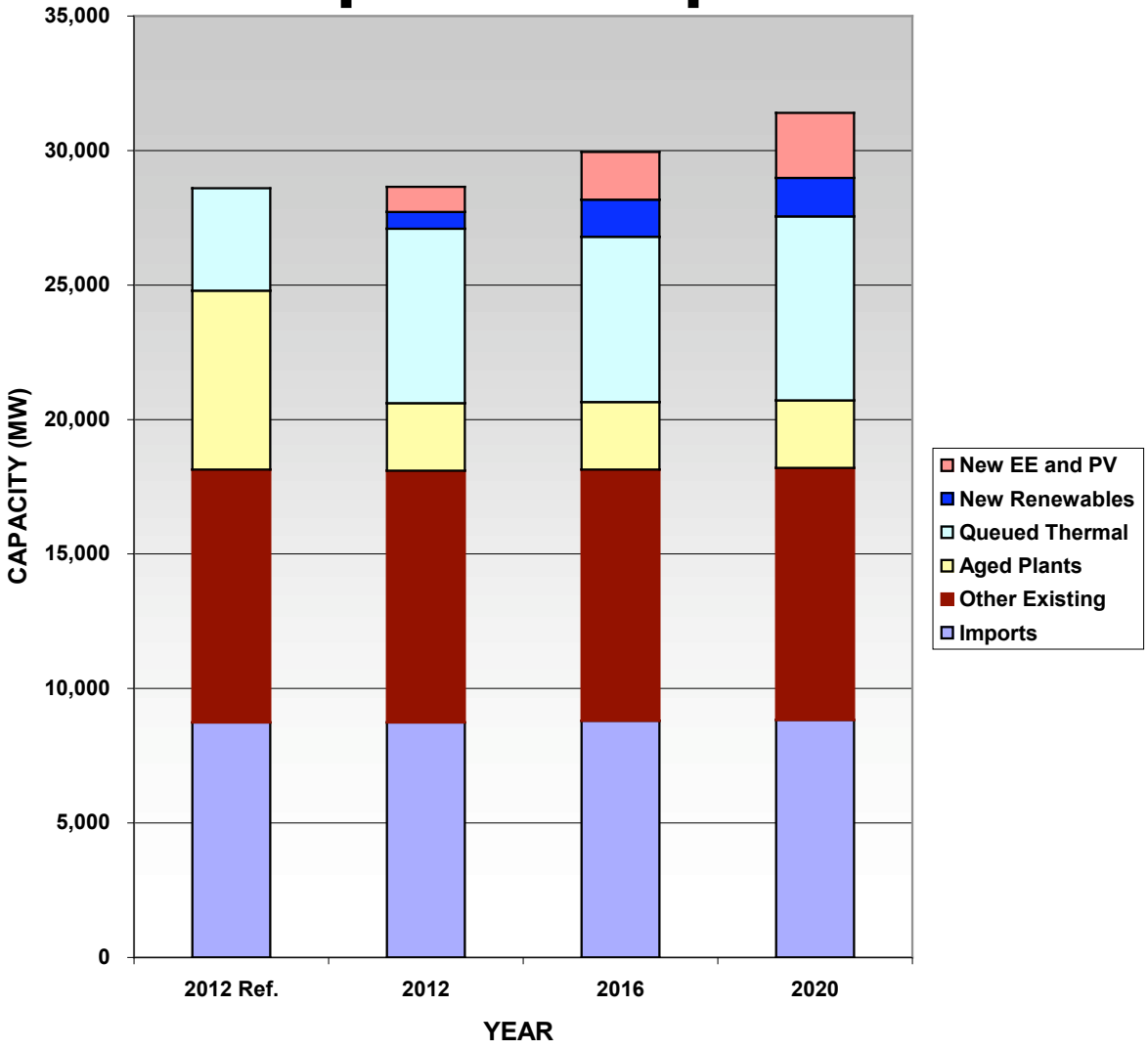
# Modeling of Scenario Resources

- Loads at all SCE load busses were reduced on a pro-rata basis to reflect energy efficiency impacts
- Solar (PV) resources and biomass resources were modeled at select busses based on information used in the Intermittency Analysis Project; specifically:
  - PV resources were modeled at approximately 50 busses in all three Cases
  - Biomass resources were modeled at 8 busses in Cases 1A and 3A and at 24 busses in Case 4A
- The dependable capacity of solar (CSP) resources was assumed to be equal to 87% of the installed capacity

# Modeling of Scenario Resources

- The dependable capacity of wind resources in the Tehachapi area was modeled as being equal to 22% of the installed capacity
- The dependable capacity of wind resources in all other portions of the SCE area was modeled as being equal to 29% of the installed capacity
- The location and magnitudes of solar (CSP) and wind resources in the various areas was based on information in the CAISO interconnection queue

# Resource Dispatch – Updated Case 1B

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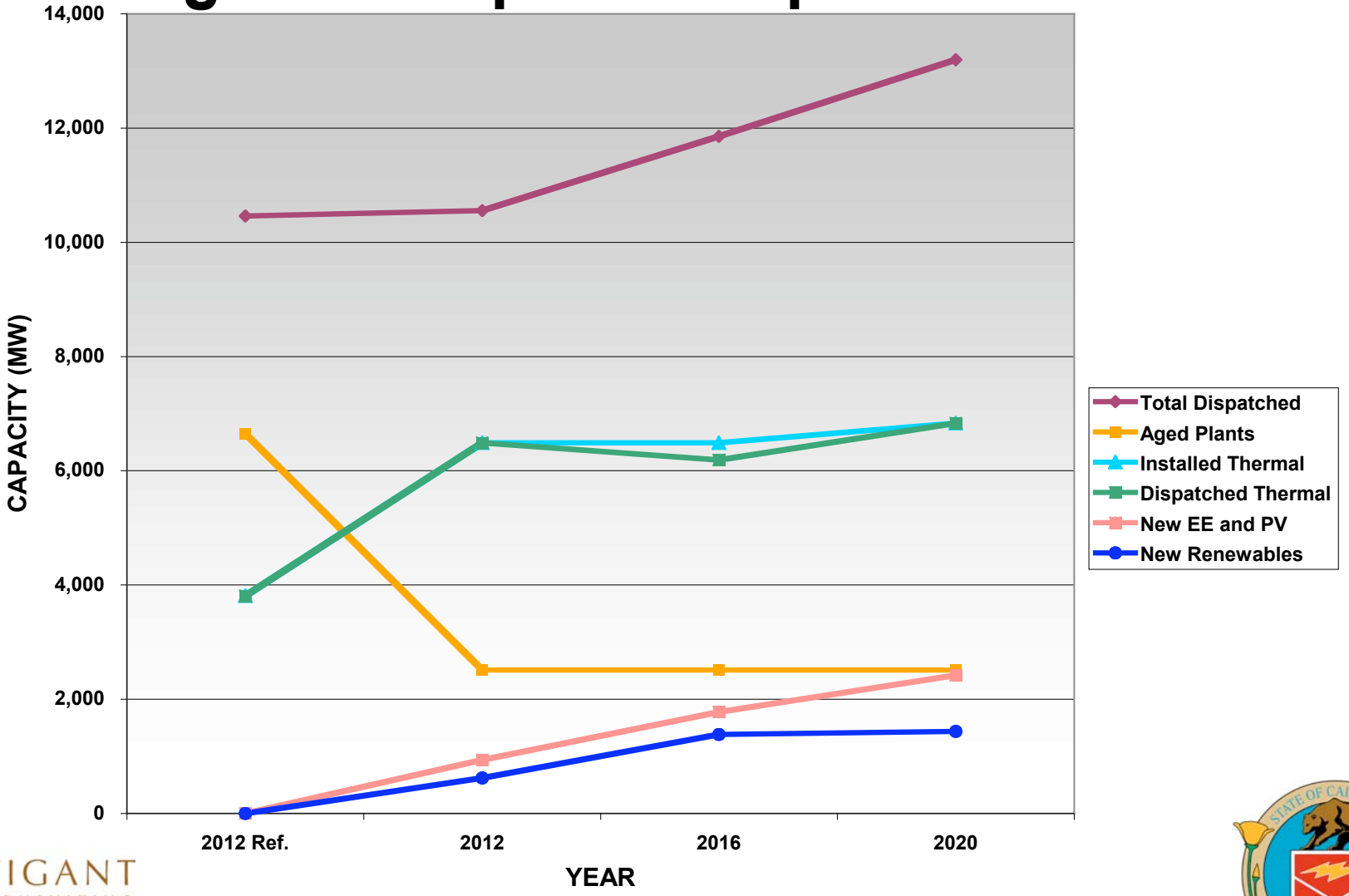
# Changes in Dispatch – Updated Case 1B

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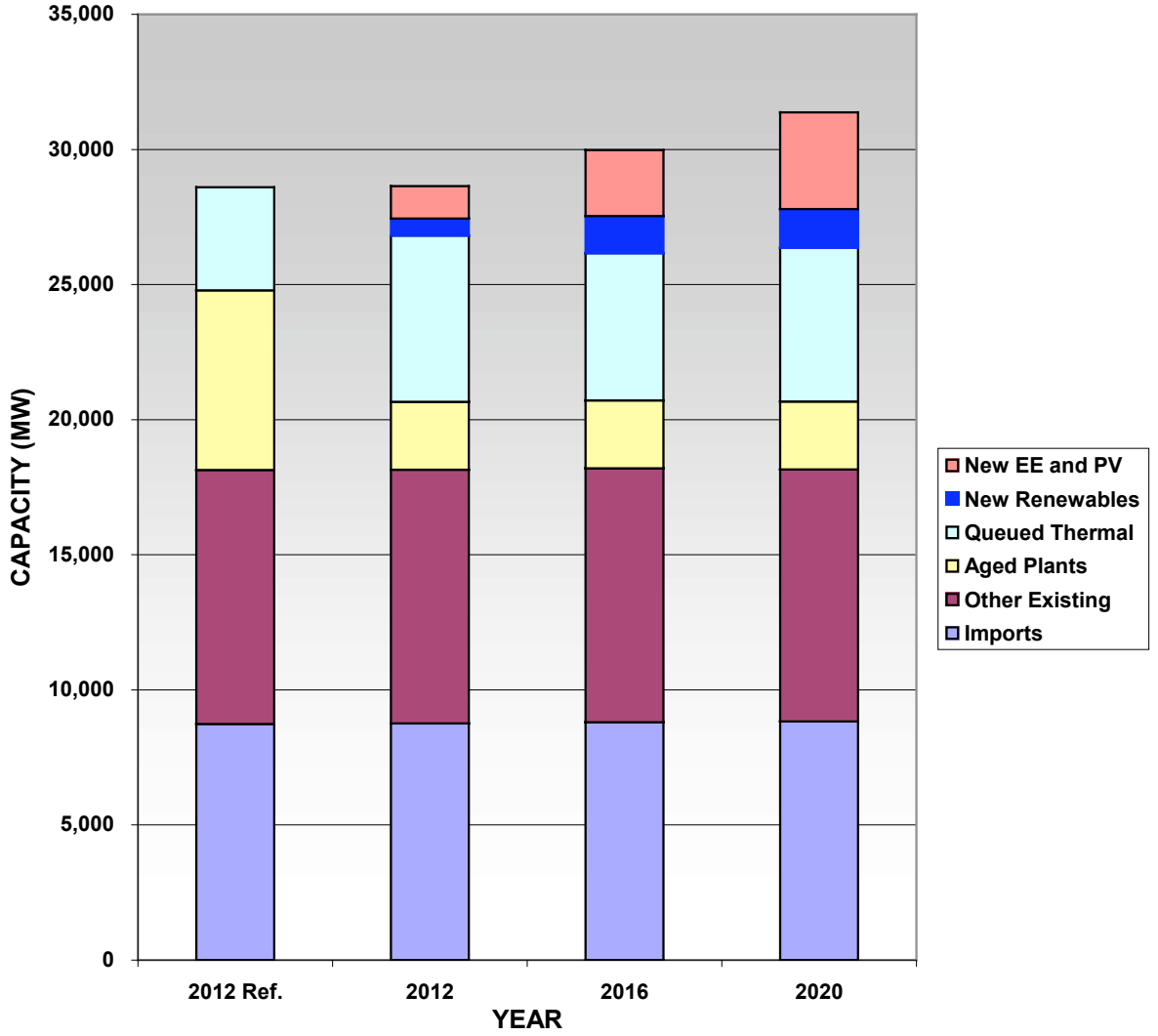
# Resource Dispatch – Updated Case 3A

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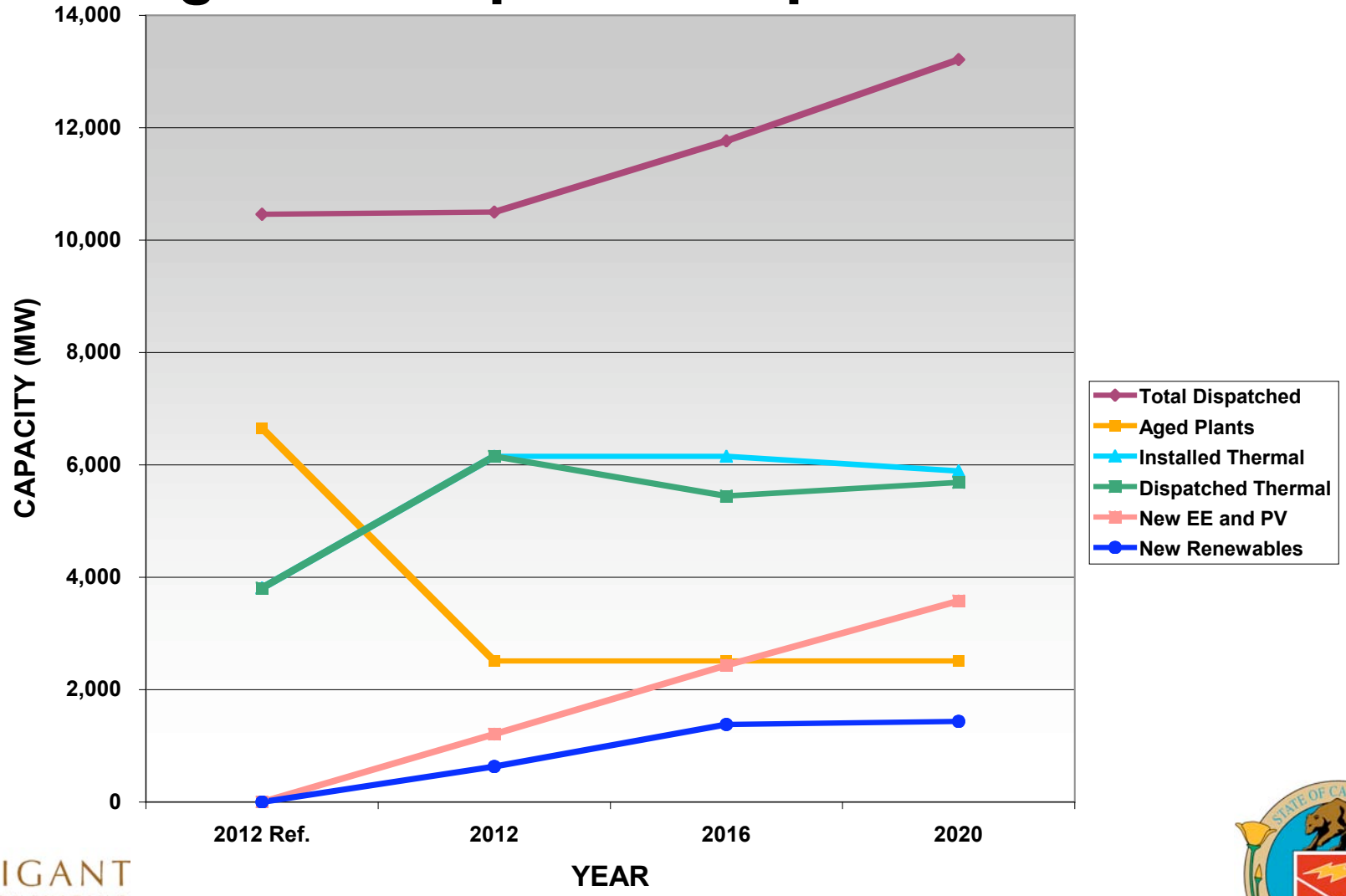
# Changes in Dispatch – Updated Case 3A

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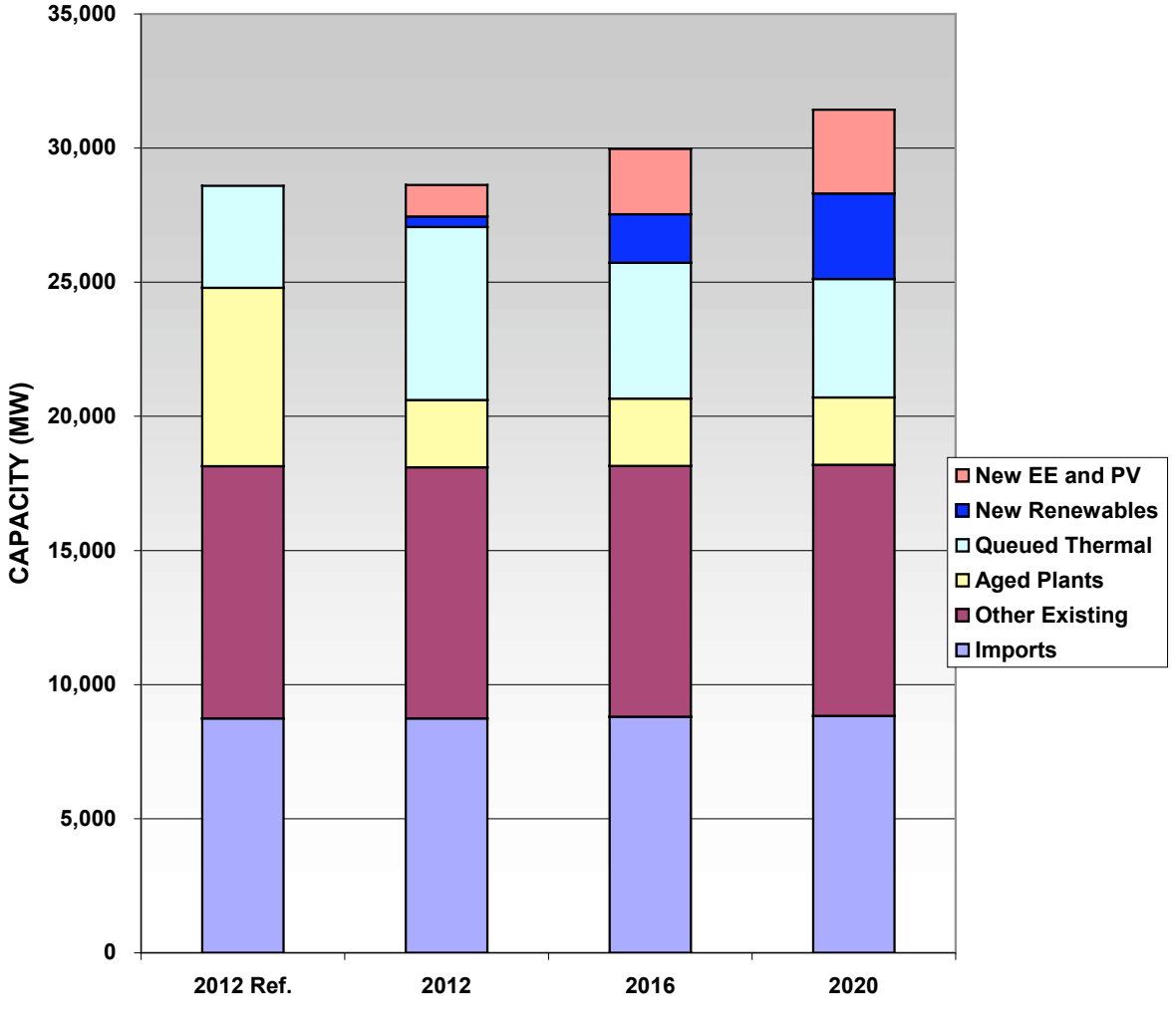
# Resource Dispatch – Updated Case 4A

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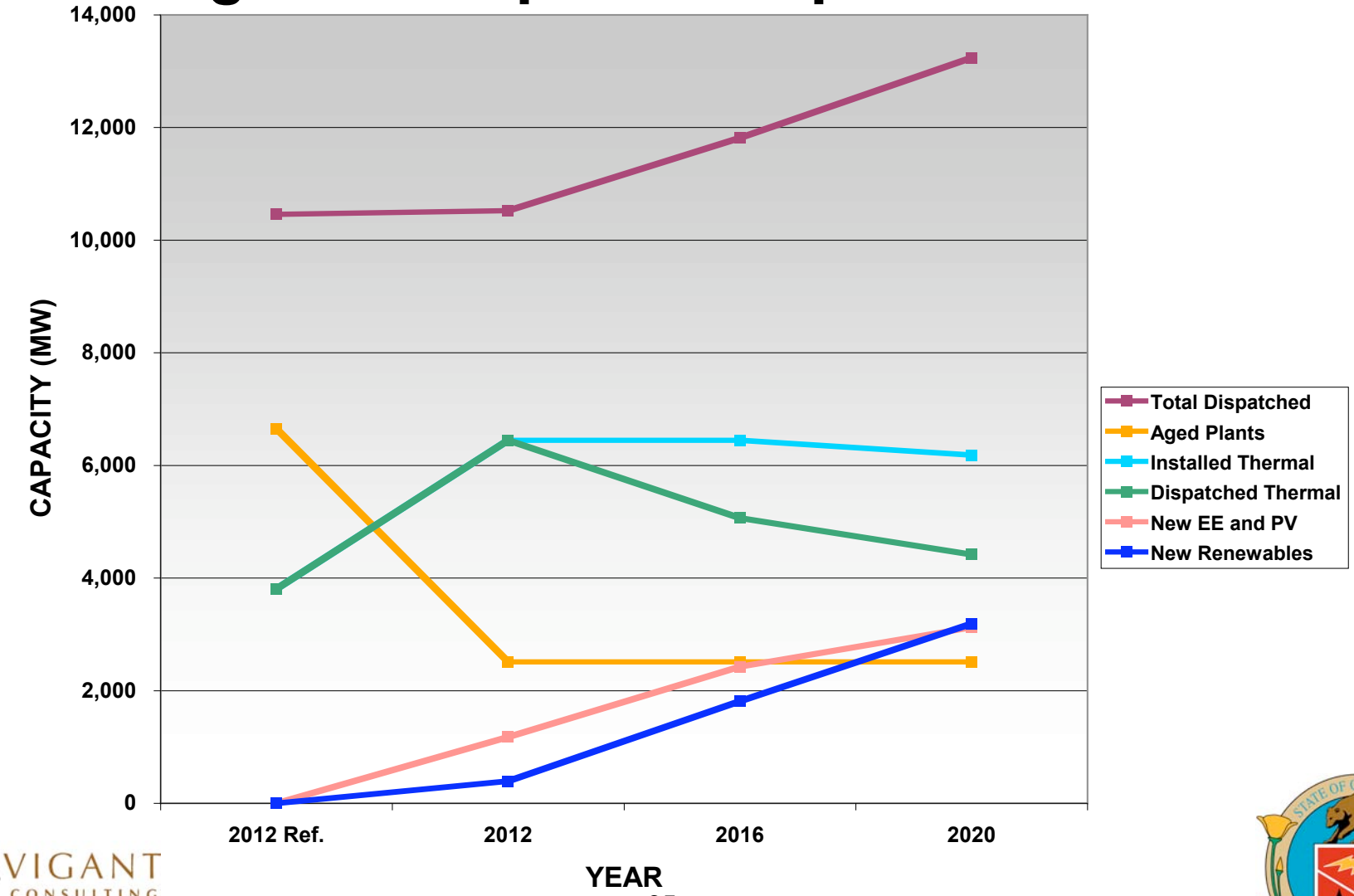
# Changes in Dispatch – Updated Case 4A

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# Results of Studies on Updated Cases

- Powerflow analysis indicated that overloads could occur on several 230-kV lines as a result of Aged Plant retirements. Specifically:
  - For Cases 1B, 3A, and 4A overloads could occur on:
    - Chino-Mira Loma #1 (7 miles)
    - Chino-Mira Loma #3 (6 miles)
    - Barre-Ellis (13 miles)
    - Moorpark-Pardee #2 and #3 (26 miles each)
  - For Case 1B overloads could occur on:
    - Redondo-La Fresa #1 and #2 (5 miles each)
    - Serrano-Villa Park #1 and #2 (3 miles each)

# Estimated Mitigation Costs - Updated Cases

| SUMMARY OF ESTIMATED MITIGATION COSTS ($Millions – 2007) | | | |
|---|---|---|---|
| | Case | | |
| | 1B | 3A | 4A |
| **2012 Additions** | | | |
| Chino-Mira Loma Upgrades | 36.4 | 36.4 | 36.4 |
| Barre -Ellis Upgrades | 28.9 | 28.9 | 28.9 |
| Moorpark -Pardee Upgrades | 3.2 | 3.2 | 3.2 |
| La Fresa -Redondo Upgrades | 0.1 | 0.1 | 0.1 |
| Serrano -Villa Park Upgrades | 0 | 0 | 0 |
| 2012 Total | 68.6 | 68.6 | 68.6 |
| **2016 Additions** | | | |
| 237 MVAR of Capacitors | 10.8 | 10.8 | 10.8 |
| 2016 Total | 10.8 | 10.8 | 10.8 |
| **2020 Additions** | | | |
| Pardee 500/230 -kV Substation | 92.6 | 92.6 | 92.6 |
| Vincent 500 -kV Ad ditions | 6.3 | 6.3 | 6.3 |
| 237 MVAR of Capacitors | 10.8 | 10.8 | 10.8 |
| 2020 Total | 109.7 | 109.7 | 109.7 |
| Total For All Years | 189.1 | 189.1 | 189.1 |

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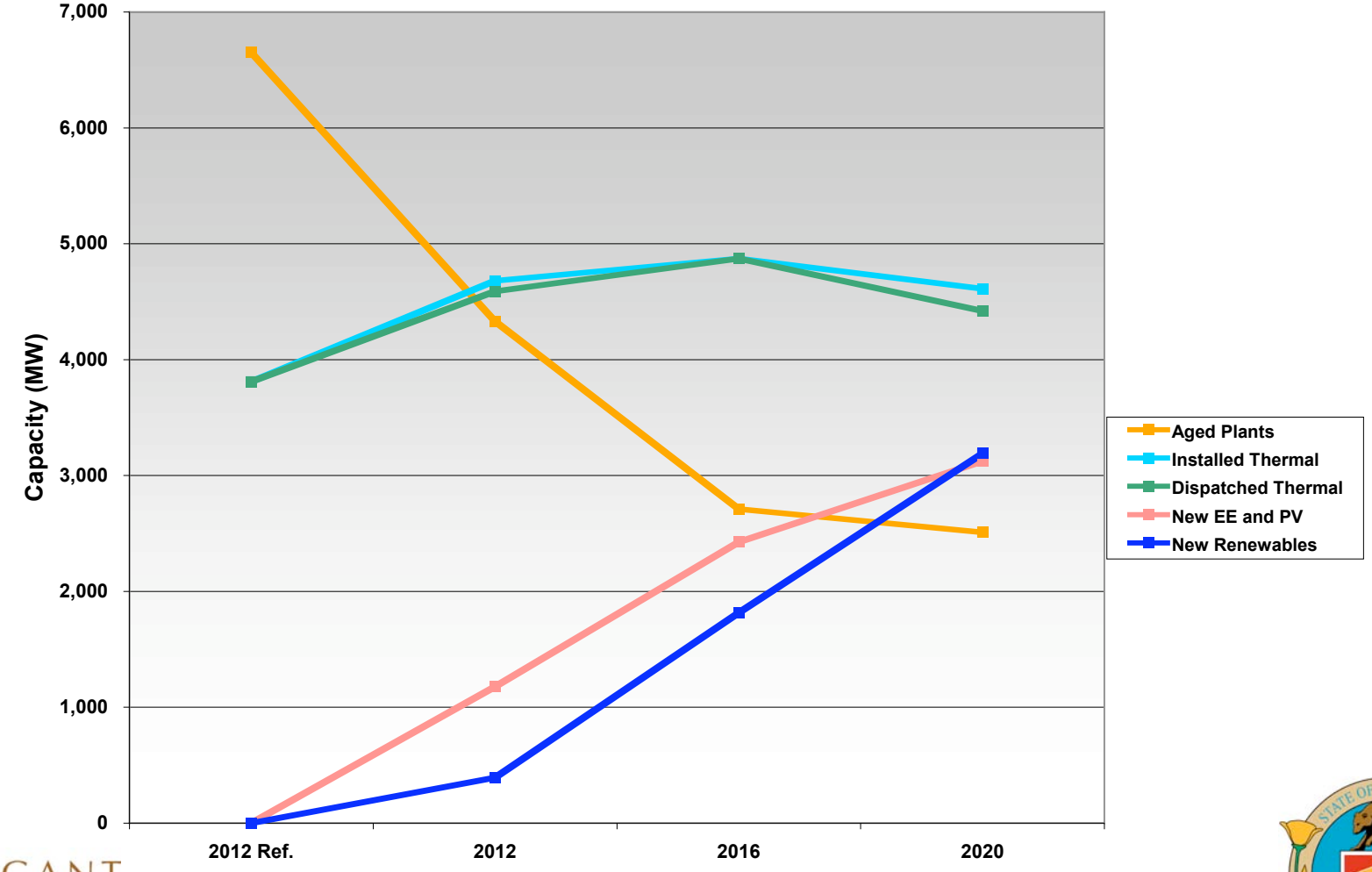
# Results of Studies on Updated Cases

- The powerflow analysis also indicated that overloads could occur on several other lines as a result of renewable resources being interconnected in the Pisgah and southern Nevada areas. These include:
  - The Lugo-Pisgah #1 and #2 230-kV lines
  - The El Dorado-Pisgah #1 and #2 230-kV lines
  - The El Dorado-Lugo 500-kV line
- These studies also indicated that overloads could occur on the Palo Verde-Devers #1 line due to the magnitude of imports from Arizona and the interconnection of generation with the line at the Midpoint substation.

# Development of Phased-Retirement Cases

- As a result of the potential "under-utilization" of thermal replacement capacity discussed previously, additional Cases were developed in which the Aged Plant retirements were phased. Specifically:
  - For Case 1B and Case 3A the retirement of both units at Huntington Beach and one unit at Mandalay were deferred from 2012 to 2013
  - For Case 4A retirements were deferred as follows:
    - Ormond Beach units from 2102 to 2015
    - Mandalay units from 2012 to 2016
    - One Huntington Beach unit from 2012 to 2016
    - Other Huntington Beach unit from 2012 to 2018

# Changes in Dispatch
# Case 4A With Phased Retirements

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# Results of Studies on Phased-Retirement Cases

- The powerflow analysis on the Phased-Retirement Cases indicated that:
  - The need to upgrade the Chino-Mira Loma #1 line and the could be deferred until 2016 for Cases 1B and 3A and until 2020 for Case 4A
  - The need to upgrade the Barre-Ellis line could be deferred until 2016 for Cases 1B and 3A and until 2020 for Case 4A
  - The need to upgrade the Moorpark-Pardee #2 and #3 lines could be deferred until 2016 for Case 4A

# Results of Studies on Phased-Retirement Cases

- The study results presented earlier indicate that, for all three Cases, maintaining approximately 400 MW of additional capacity at Huntington Beach could:
  - Defer the costs associated with upgrading the Barre-Ellis line (approximately $29 Million) until the 2020 time frame
  - Defer the need to upgrade the Chino-Mira Loma #1 line until the 2020 time frame
- The capacity at Huntington Beach could be maintained by:
  - Not retiring or repowering Units 1 and 2, or
  - Developing new generation in the proximity of the Huntington Beach plant

# Preliminary Assessment of LCR Impacts

- In April 2007 the California ISO issued a report regarding the Local Capacity Requirement for various areas of the system in California in 2008. Pertinent information regarding the LA Basin and Big Creek/Ventura areas is summarized in the following table.

| SUMMARY OF CALIFORNIA ISO 2008 LCR REPORT (MW) | | |
|---|---|---|
| | **LA Basin Area** | **BC/Ventura Area** |
| Area Load | 19,658 | 5,011 |
| Local Capacity Requirement | 10,130 | 3,658 |
| Assumed Import Level | 9,528 | 1,353 |
| Available Capacity | | |
| - QF | 780 | 1,117 |
| - Wind | 11 | 346 |
| - Municipal Owned | 508 | 0 |
| - Nuclear | 2,246 | 0 |
| - Market | 8,814 | 3,933 |
| Total | 12,359 | 5,396 |

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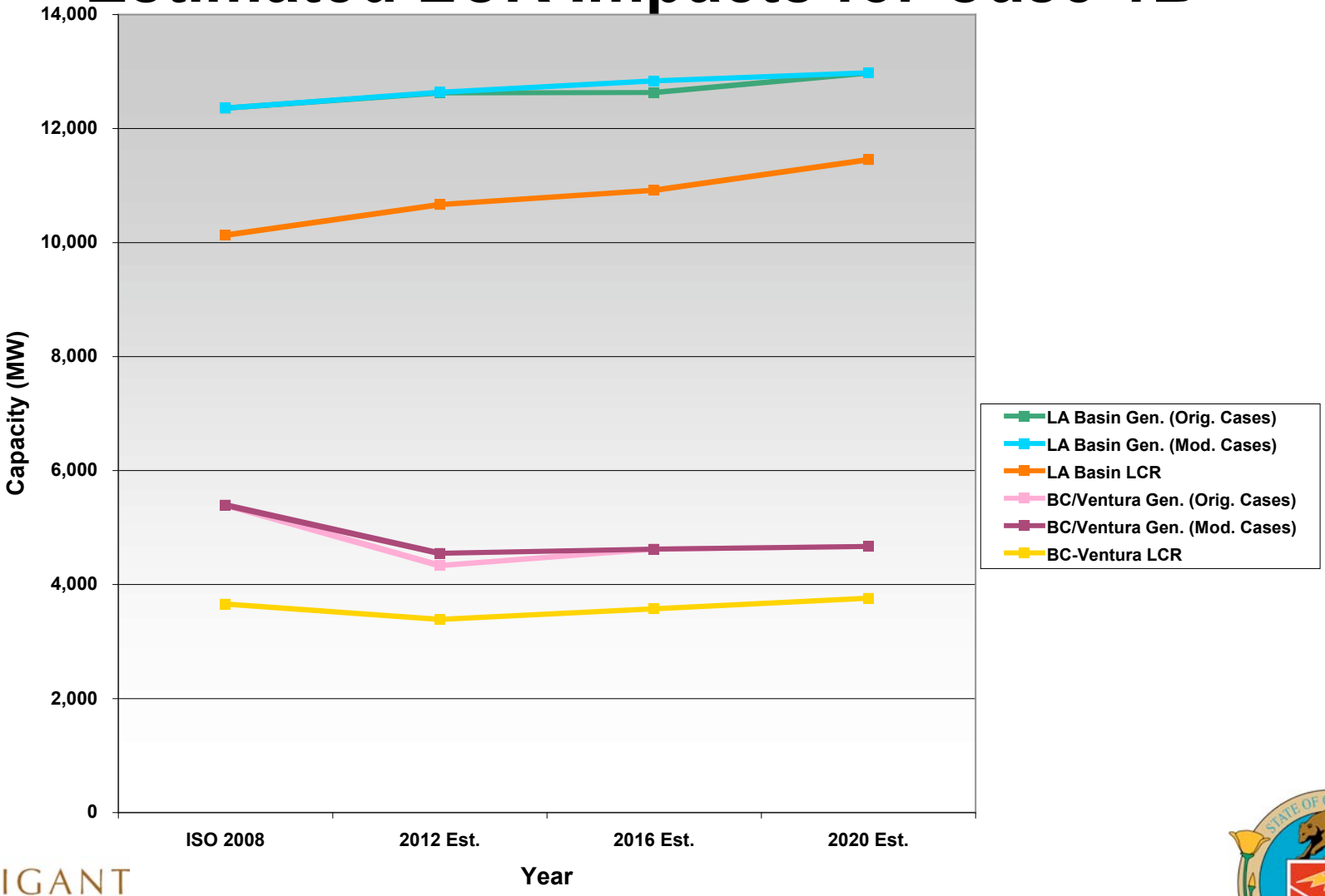
# Preliminary Assessment of LCR Impacts

- NCI has developed a preliminary assessment of the impacts on generation available to meet LCR for the three Cases discussed above.
- In developing this assessment it was assumed that:
  - The import limit for the LA Basin Area would remain at the 9,528 MW level shown in the previous table
  - The import limit for the Big Creek/Ventura Area would increase by 600 MW above the 2007 level due to the addition of the Tehachapi Renewable Transmission Project
  - The load in each Area would reflect a pro-rata share of the potential demand side resources (energy efficiency and PV solar) defined for each of the Cases
  - The LCR for each Area would be equal to the adjusted load less the import limit

# Preliminary Assessment of LCR Impacts

- In developing this assessment it was also assumed that the Available Capacity in the Big Creek/Ventura Area would include wind capacity equal to 20% of the installed capacity in the Area (in its LCR studies for 2007, the ISO assumed that 100% of the installed wind capacity would be available for LCR).
- As depicted on the following graphs, this preliminary assessment indicated that there would be ample capacity in each Area to meet the Area's LCR for all of the Cases studied when the thermal additions defined in the Study were included as part of the available capacity

# Estimated LCR Impacts for Case 1B

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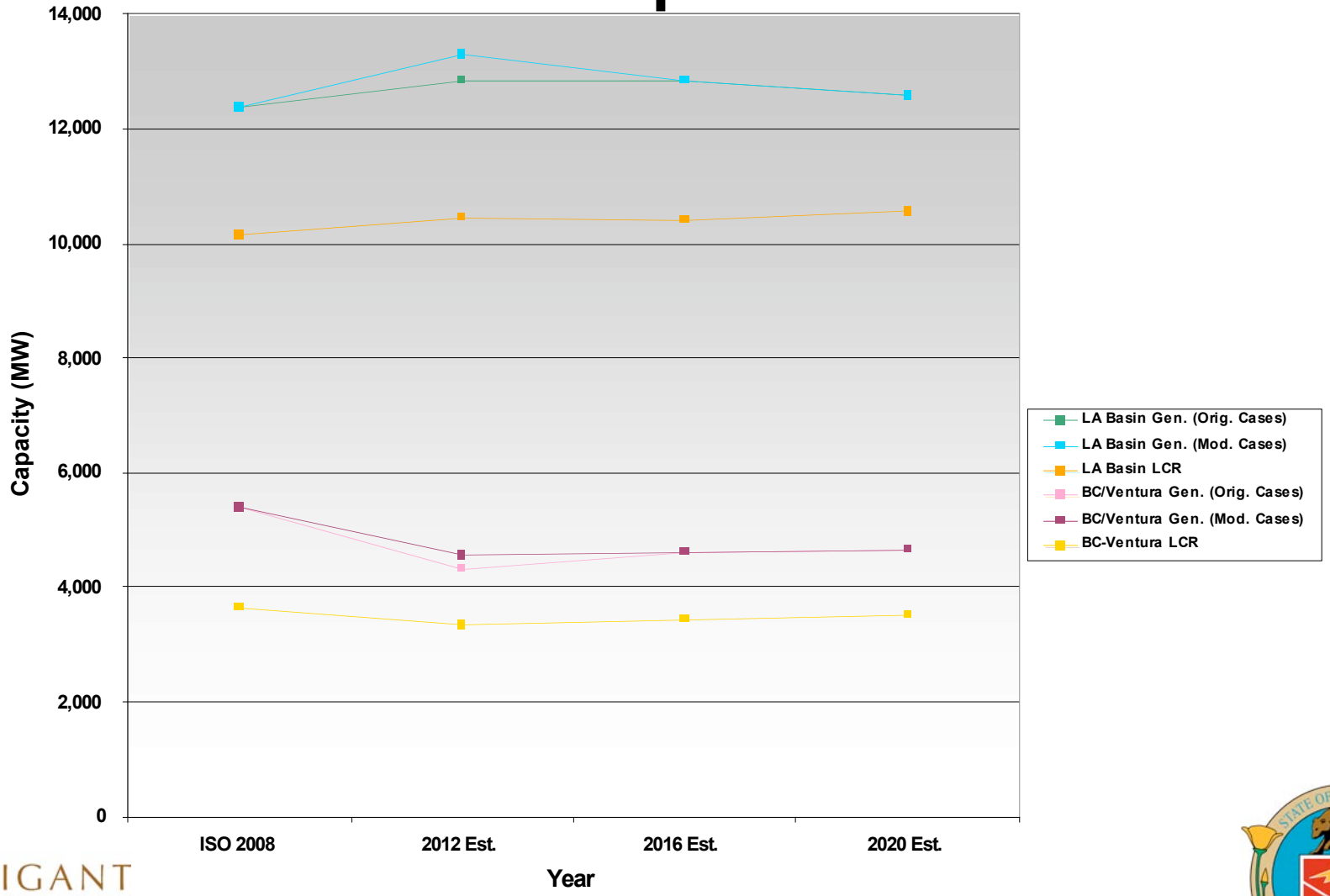
# Estimated LCR Impacts for Case 3A

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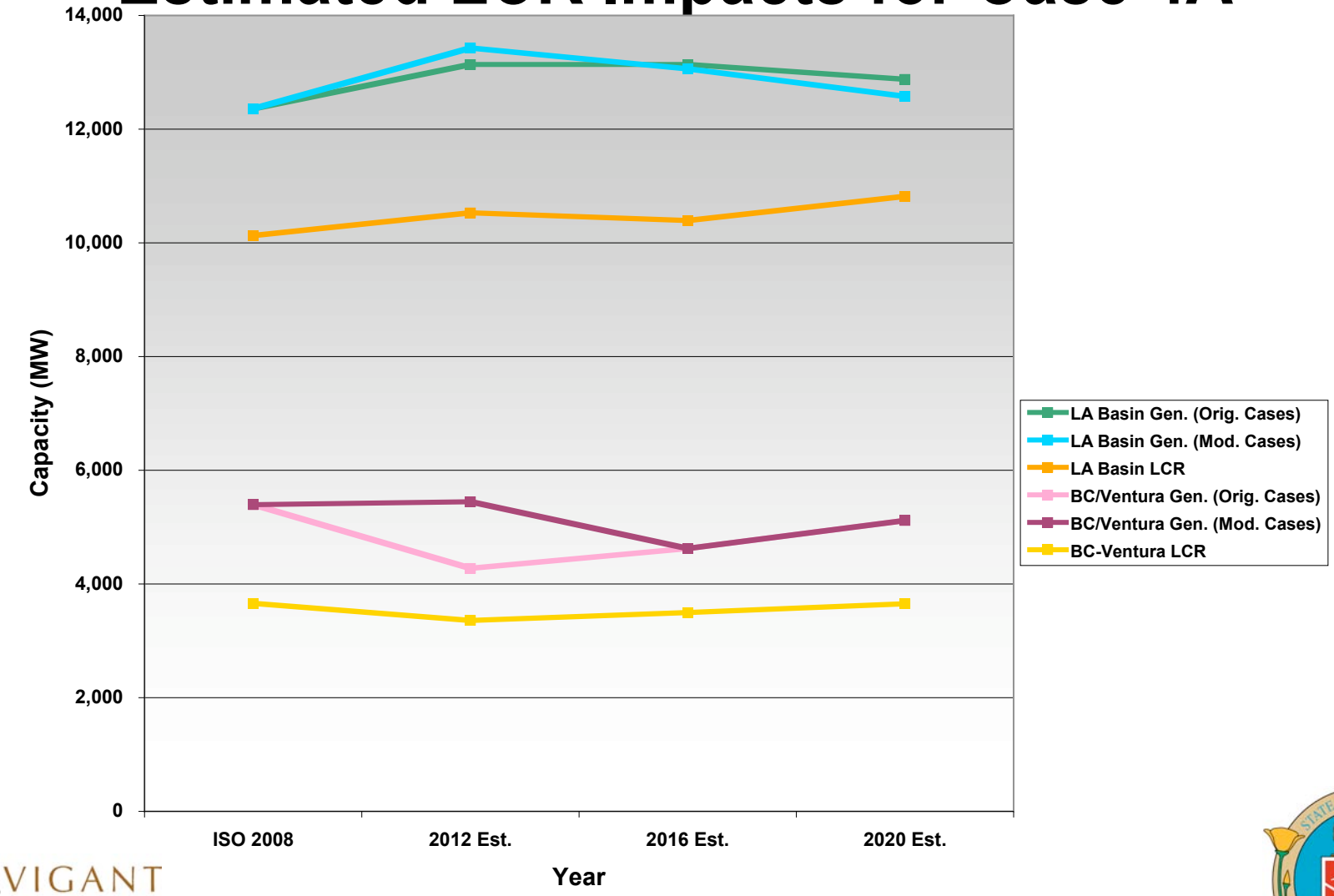
# Estimated LCR Impacts for Case 4A

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# Coordination With Other Parties

- As previously noted by Staff:
  - There was extensive coordination between NCI, Energy Commission Staff, and Global Energy Decisions during the Aging Plant retirement study
  - With respect to the CAISO and SCE, there has been limited coordination to date. However:
    - CAISO provided suggestions about contingency assessment to better coordinate with approach used for LCR studies
    - Two conference calls were held with SCE during which the study was discussed
    - SCE transmission planning staff provided information regarding recent changes in transmission line ratings and the limiting elements of key transmission lines
    - Both parties reviewed the draft report as “sanity check.”

# Conclusions

- Conclusions from the Aged Plant study include:
  - The retirement of 4,140 MW of Aged Plant generation in the SCE area would require that significant upgrades be made to the transmission system and that significant amounts of replacement capacity be available
  - Developing the required transmission upgrades and replacement capacity by 2012 could be problematical due to a number of issues
  - The increased levels of energy efficiency and renewable energy resources that could be developed by the 2016 time frame could have a significant impact on the timing of unit retirements and the need for and timing of replacement resources

# Conclusions (Continued)

- A more detailed assessment of licensing and permitting, acquiring rights-of-way for, planning, and constructing the anticipated renewable resources, the proposed conventional resources, and the required transmission system upgrades is needed to determine an optimal schedule for unit retirements
- A final optimized plan for the combined impacts of unit retirements, transmission system upgrades, and development of replacement capacity should be developed.
- This plan should involve all of the pertinent parties, further address potential LCR impacts, and address operation under existing operating procedures.